Factsheet

U5 Metro Line Hamburg

Construction follows roadmap for CO_2 reduction

Decarbonisation given priority in construction of new U5 metro line in Hamburg / First section being realised by ZÜBLIN and Wayss & Freytag

A low-carbon design-and-build process, fully automatic and with zero emissions in operation: Hamburger Hochbahn AG (HOCHBAHN), represented by HOCHBAHN U5 Projekt GmbH, is setting standards in consistent decarbonisation with the construction of the new U5 metro line in Hamburg. In a joint venture with Wayss & Freytag, ZÜBLIN is realising the first construction section of this major infrastructure project, the implementation of which follows the central premise of minimising greenhouse gas (GHG) emissions at all levels.

The approach is unprecedented in Germany: For the first time ever, a construction project of this size is being realised entirely with CO_2 reduction in mind – from the low-carbon design to the use of climate-friendly construction methods and processes to the selection of absolute low-carbon materials. The aim is to achieve a significant carbon reduction of 70%. In concrete terms, the reduction strategy (greenhouse gas roadmap) should reduce the overall emissions of the project to 850,000 tonnes of CO_2 compared to 2.7 million tonnes from a project realised using conventional construction methods.

Cover Rendering of U5 Bramfeld station
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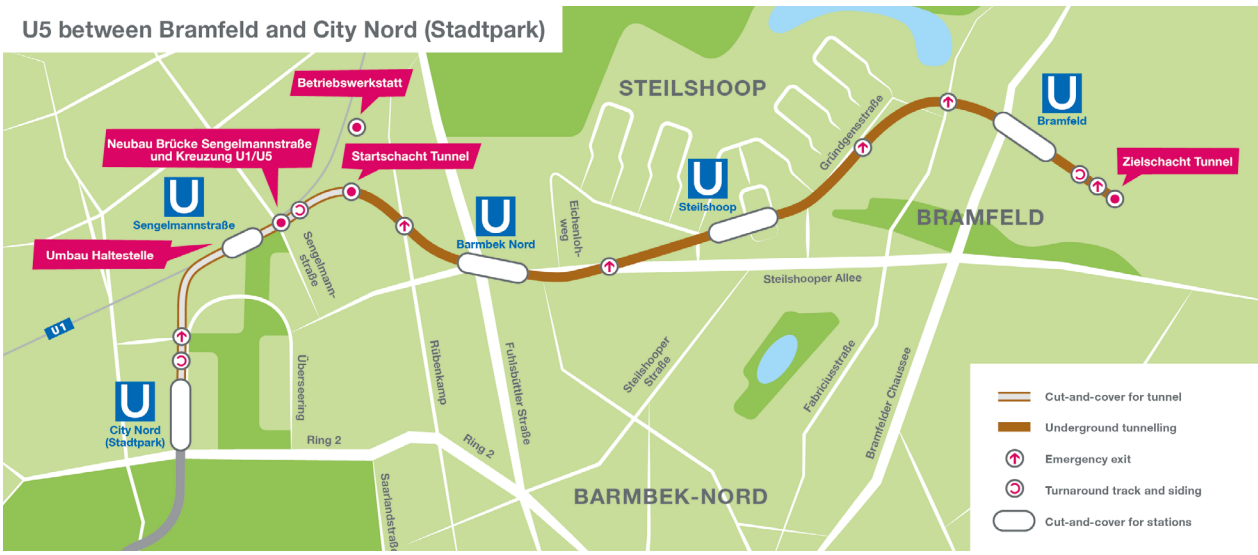
U5 metro line: fast and with zero emissions through Hamburg

The new U5 metro line across Hamburg is the largest public transport infrastructure project in Germany currently under construction. Hamburg's fifth metro line will add a completely new east-west axis to HOCHBAHN's transport network, linking the districts in the east (Bramfeld, Steilshoop) and the west (Lurup, Osdorf and the Volkspark arenas) with the city centre (central railway station) over a distance of around 29 kilometres. The line encircles the Outer and Inner Alster lakes, runs through the city in a U-shape and connects 24 stations with pioneering technology: The U5 will be Hamburg's first fully automatic underground railway line. Once the overall project is completed (in 2040, according to current planning), HOCHBAHN estimates that around 345,000 passengers will use the new line every day. Powered by green electricity, the U5 is key to the mobility transition and part of Hamburg's goal to becoming climate-neutral by the year 2045.



Start in the north-east: ZÜBLIN and Wayss & Freytag building first section of U5

Construction work on this large-scale project has been in full swing in northeastern Hamburg since the official ground-breaking in autumn of 2022, with ZÜBLIN and Wayss & Freytag jointly working on the first construction section of the U5 between Bramfeld and City Nord (Stadtpark). A consortium of the two companies was awarded the contract for two staggered lots (Lots 1 and 2) by HOCHBAHN U5 Projekt GmbH. Four new underground stops (Bramfeld, Steilshoop, Barmbek Nord, City Nord) are being built on the 5.8-kilometre section of the new line. In addition, the existing Sengelmannstraße U1 station will be converted into an above-ground transfer between the U1 and U5 lines. The consortium's project team is building the section between City Nord and Sengelmannstraße (Lot 1) – including the new stations – using the cut-and-cover method.



1 First U5 construction section (Lots 1 and 2)
© HOCHBAHN

The approximately four-kilometre-long section between Sengelmannstraße and Bramfeld (Lot 2), to be built starting in 2027, will be excavated using a tunnel boring machine. Until then, the Lot 2 project team will successively construct the excavation pits for the stations and for the emergency exits using reinforced concrete diaphragm walls along the planned route. The first section, from City Nord to Sengelmannstraße, is due to be completed by 2027, and extensive trial operations of the fully automated trains are scheduled to start there in the same year. Meanwhile, in-depth planning is underway for the rest of the route to the west. The contracts for the subsequent construction sections will be awarded gradually over the coming years.



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2 For soil management on the construction site, the project team in Lot 2 is using a zero-emission electric wheel loader. © Ed. Züblin AG, Sebastian Engels Fotografie / **3** Lifting of fully assembled rebar cages by crane at the U5 construction site in northeastern Hamburg. © Ed. Züblin AG, Sebastian Engels Fotografie

Green electricity and low-carbon building materials

Reducing the level of CO_2 emissions during construction starts with the energy supply. The necessary electricity, for example for the tunnel boring machines, will be supplied entirely from renewable sources (green electricity). Soil management (excavation, transport, recycling) and logistics are also designed to be as sustainable and with as few emissions as possible. For this purpose, ZÜBLIN and Wayss & Freytag are using a climate-friendly electric wheel loader on site for Lot 2. The consortium's other construction vehicles are fuelled with HVO diesel made from hydrogenated vegetable oils, which reduces CO_2 emissions by up to 90 per cent compared with diesel made from fossil fuels.

Despite the material-saving design, the material requirements for the project are immense. A total of around 4 million cubic metres of concrete and 600,000 tonnes of steel will be needed to build the new metro line in the coming years – vast quantities that could have an enormous potential impact in terms of harmful emissions. A big problem are the high-carbon manufacturing processes involved in producing the cement needed as a concrete binder, especially the clinker (clay and limestone) contained within the cement, as well as the primary steel from the coal-based blast furnace. The key to truly significant CO_2 reductions therefore lies in the production of the concrete, cement and steel used. In order to achieve the GHG roadmap's targets for the project, HOCHBAHN U5 Projekt GmbH plans to use the most climate-friendly building materials currently available on the market. But the company is also taking the concrete and steel manufacturers to task, focusing on technical progress in the course of the project by calling for the further development and introduction of sustainable production processes, for example.

Material-saving planning for lower carbon emissions

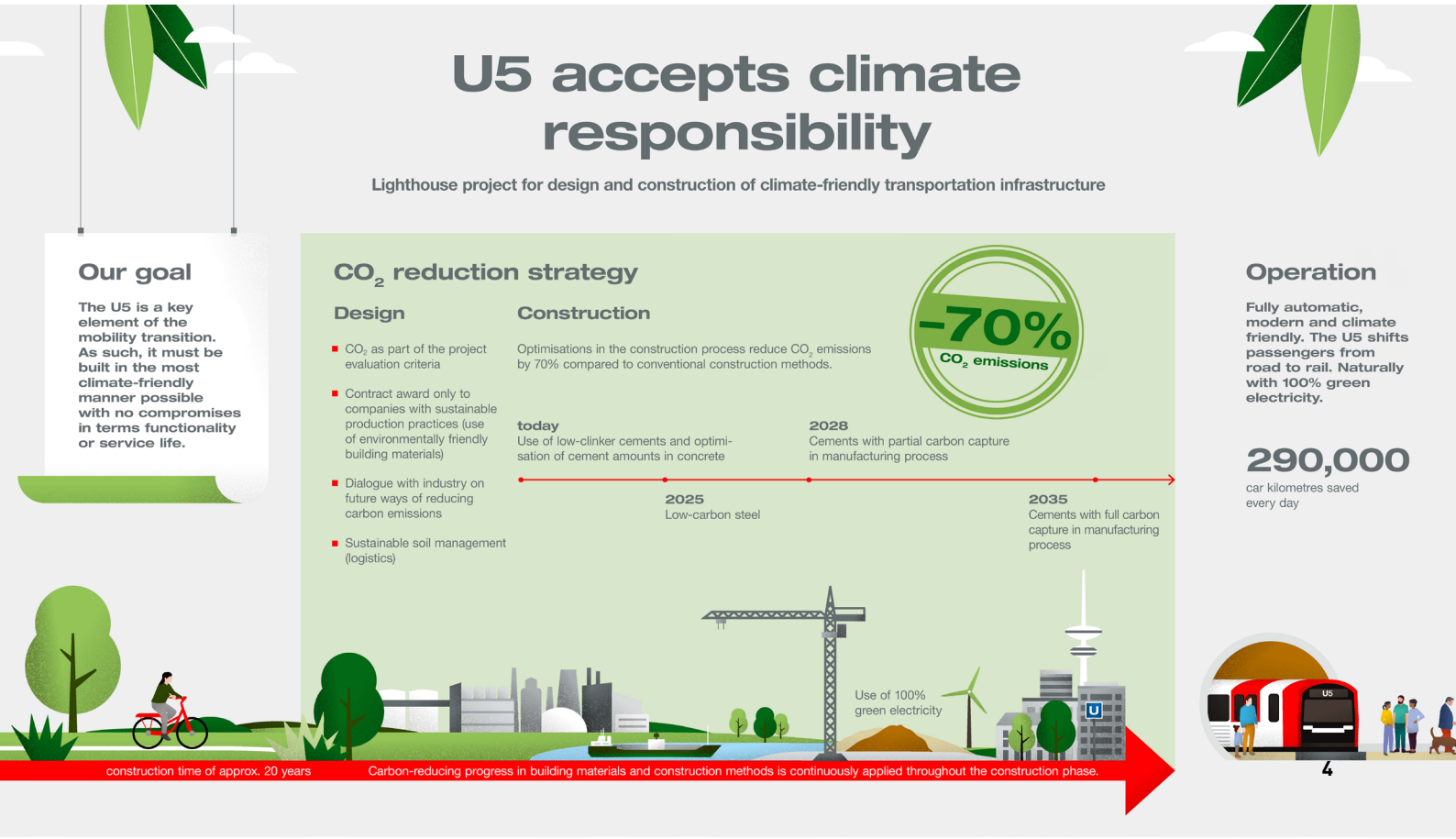
An important factor in reducing harmful emissions is the construction method specified in the design. As a large proportion of the carbon emissions are attributable to the use of reinforced concrete, this important first step is all about minimising material use. In other words: less is more. The engineers at HOCHBAHN U5 Projekt GmbH therefore optimised the planning and design with a focus on material savings and low-carbon construction processes. Top priority, however, was given to avoiding compromises in terms of passenger comfort, functionality and service life. Example: For the U5 tunnel, steel-fibre-reinforced concrete segments are being installed using a tunnel boring machine for the first time in Germany. A special case-by-case approval obtained specifically for the U5 will make this possible starting in 2027 on the first construction phase. This technical innovation is a key component of the CO_2 reduction strategy for the U5: compared to standard segments with conventional reinforcement, the fibre solution reduces steel requirements by around 60 per cent – thereby also reducing the carbon footprint of the concrete segments accordingly.



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> "We're actually carrying out development work here – that's quite unique in Germany."
>
> **Christian Hoffmann,**
> Ed. Züblin AG, Construction Manager

The project's carbon reduction plan is reflected in the day-to-day work of the ZÜBLIN and Wayss & Freytag teams. In the tendering process for building materials, for example, the GHG load is an additional award criterion that the manufacturers must verify through corresponding certification. To control and manage the reduction strategy, the actual carbon emissions of the construction work and of the materials used are documented and monitored in a continuous carbon footprint assessment performed for the duration of construction.



4 CO_2 reduction strategy / HOCHBAHN's GHG roadmap for metro line 5 © HOCHBAHN

Cement composition a decisive factor for reducing CO_2 in concrete

The consortium is focusing specifically on the use of low-carbon concrete during construction of the U5 metro line. The project team is using two key levers here to keep the GHG load to a minimum: reducing the amount of cement in the concrete and using concrete with a low clinker content. Cement is an important part of concrete, affecting curing time and stability. The key consideration for optimising the carbon footprint of the project is therefore to use as little cement as possible (but as much as is technically required). "We are pushing the limits of what is technically feasible here," says Christian Hoffmann, ZÜBLIN project manager for Lot 1 of the first construction section – for example, by using concrete types with a reduced proportion of clinker in the cement. The clinker is replaced by other additives such as fly ash or ground granulated blast-furnace slag, which have similar chemical and physical properties as clinker but produce significantly fewer harmful emissions. Initial type testing of the building materials for their carbon reduction properties defines the concrete requirements for each possible use case during construction. Christian Hoffmann: "We're actually carrying out development work here – that's quite unique in Germany." HOCHBAHN U5 Projekt GmbH is also hoping that cements with partial (and later full) carbon capture in the manufacturing process can be used for the construction work by the end of the decade. The industry is currently working on solutions for sequestering and storing the carbon dioxide generated during production to prevent it from being released into the atmosphere in the first place.

Low-carbon steel grades for the new metro line

HOCHBAHN U5 Projekt GmbH is betting on the industry gradually switching to more climate-friendly production methods for steel as well. The consortium of ZÜBLIN and Wayss & Freytag is already making use of low-carbon steel grades for Lot 2 of the first construction section. The carbon footprint of the reinforcing steel used in the project is currently not allowed to exceed a maximum GHG load of 500 kg of CO_2 per tonne. Compared to reinforcing steel produced conventionally in blast furnaces, however, this will significantly reduce carbon emissions by more than half. This reduction is made possible through the use of green electricity during production and by using recycled scrap metal from electric arc furnaces. The steel supplier must provide evidence of this reduction: “What we need here are environmental product declarations, or EPDs,” says Yves Grebing, ZÜBLIN overall project manager for Lot 2. And the transport routes must be made transparent as well. “We have to prove that the low-carbon steel actually ends up on the construction site,” Grebing explains. The process, which has the potential to become a model for the future, puts the U5 in a pioneering position in Germany. HOCHBAHN U5 Projekt GmbH is firmly committed to making further progress on sustainability in steel production in the future. Consistent climate change mitigation in this context means switching from coal-based blast furnaces to primary steel production using green hydrogen (direct reduction).



Fully automatic operation as key to mobility transition

Powered by 100% green electricity, the U5 metro line will help prevent millions of car journeys in Hamburg once it is up and running while also reducing emissions, noise, traffic jams and accidents. According to projections by transport planners, the U5 has the potential to save around 290,000 car kilometres a day – the equivalent of seven trips around the world. The advantages of the new line’s fully automatic operation are intended to win people over to public transportation by encouraging them to switch from cars to the metro on a large scale as the innovative technology will enable flexible and needs-based train scheduling: During peak hours, the centrally controlled trains will be able to serve the line at 90-second intervals depending on passenger volumes. This should make the U5 an attractive mobility alternative: not only is it more environmentally friendly, it is also considerably faster than travelling by (private) car.

5 Low-carbon concrete types are specifically being used in the construction of the U5 – for example, concrete made with low-clinker cement. © Ed. Züblin AG, Sebastian Engels Fotografie /
6 U5 Sengelmannstraße station © Hamburger Hochbahn AG, Visualisierung: beyond visual arts / Architektur: GKKS Hamburg



More information can be found on the HOCHBAHN project website:

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